are here confused, the *henotheism* (as it is called) of the earlier period of Jewish history which regarded Jehovah only as one among many Gods, the one who fought on the side of the Israelites, and who ought to be worshipped by them; and, contrasted with it, the later and truly monotheistic ideal of the prophets, which emphasised the *solity* of Jehovah. It would, at any rate, be difficult to harmonise our author's account with any of the accepted readings of Jewish history, traditional or critical. Part of the page ought probably to be re-written.

TIDES AND WAVES.

A Practical Manual of Tides and Waves. By W. H. Wheeler. Pp. viii+201. (London: Longmans, Green and Co., 1906.) Price 7*s.* 6*d.* net.

THE author of this book is a well-known civil engineer, whose practice has been largely concerned with works on the sea coast and tidal rivers. The practical side of the subject treated has consequently required and received from him long and close study; his intention in this volume has been "to give as practical an account as possible, free from all mathematical demonstration, of the action of the sun and moon in producing the tides: and of the physical causes by which the tides are affected after their generation, and of their propagation throughout the tidal waters of the earth." To these subjects the principal portion of the work is devoted; in a comparatively short section the author deals also with wave phenomena, in a manner likely to be useful to practising engineers, and not lacking in interest to a much wider circle of readers. Mr. Wheeler has given much time and thought to the production of the work, and the bibliography of his subjects (contained in an appendix) indicates a wide range of reading. In the text itself a great mass of useful information and data is summarised; this is supplemented by several valuable appendices giving results of tidal and wave observations as well as formulæ of use in engineering practice. A good index makes reference easy to the principal features of the book, and adds much to its value to readers for whom it has been chiefly designed. In one particular the scheme of the author is open to criticism: he has aimed at making "the subjects dealt with in the separate chapters complete," and this has involved some repetition of statement. Probably the explanation is that in some cases papers prepared for separate publication have been embodied in the book; but although the repetition (as the author says) may have "been avoided as much as possible," his scheme for completeness in individual chapters necessarily involves it, and in a book such as this is the result is not altogether satisfactory. This is a small drawback, however, to a work of considerable merit that will undoubtedly be welcomed by the engineering profession as a book of reference bringing together within small compass a great mass of useful information drawn from widely-scattered sources.

A historical sketch of the development of tidal science is first given ranging from the work of Copernicus to that of Sir George Darwin and Mr. Moxly. Next come descriptions in popular language of "the making of the tides," the "propagation of the tidal wave," and the mean level of the sea and range of the tides. All these subjects are illustrated by facts and figures drawn from actual observations. The effect of wind and atmospheric pressure on the tides is considered at some length, as a matter of considerable importance to engineers. Mr. Wheeler has endeavoured to formulate a rule as to variations to be expected with a given force of wind and height of tide; and considers that roughly "the effect of a moderate gale is to raise or lower the tide according to its direction as many inches as it would rise in feet under normal conditions." He gives some striking instances of abnormal tides due to gales of long continuance, the heights attained in some cases exceeding the tide-table heights by six to eight feet. In December, 1904, for example, at Grimsby, the morning tide was raised nearly seven feet, and at Hull, as well as on the Thames, about five feet above normal level by a heavy gale from the north-west. An investigation is also made of the recorded observations of variations in tides accompanying variations in atmospheric pressure, and the conclusion is reached that "it is not possible to lay down any general law applying to all parts of tidal waters." Mr. Wheeler considers that "although variation in pressure may be a primary cause of the alteration in the height of tides . . . yet the wind is a safer and more ready guide for the immediate purpose of navigation."

The chapter dealing with "River Tides" is one of the most interesting in the book, and from the nature of the case is chiefly based on actual observations. Mr. Wheeler traces the progress of the ocean tidal wave up a river channel, and shows how the distance to which the wave action reaches depends on the condition of the channel and the depth of the low-water stream. He describes the "ponding back" of the current in the river by the advance of the tidal wave, and demonstrates the necessity for the duration of the flood tide in rivers being less than that of the ebb. The phenomena of "double flow" are explained, and a distinction made between the propagation of a tidal wave up a river and the tidal current. These movements of river water are accompanied by transport of material carried in suspension, and from the engineering side this is a question of great importance which Mr. Wheeler discusses fully.

Closely related to tidal currents are tidal "bores," which occur in certain rivers. These are very fully described by the author, who summarises the conditions necessary for the full development of a bore as follows:—A considerable rise of tide, a converging channel with a rising bed, the depth of water decreasing as the channel is approached, or a sand bar over which there is not sufficient depth of water to admit of the passage of the approaching tidal wave. Under these conditions, in place of a gradual rise of the water at the entrance to the river, the arrival of the tide is accompanied by a breaking wave with a crest several feet in height, which when formed advances rapidly up the channel. In the Tsien-Tang-Kiang River,

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China, the range of spring tides is about twelve feet at the mouth; but the tidal wave becomes compressed in advancing towards the head of the estuary, and reaches twenty-five feet in height at ordinary springs and thirty-four feet when an onshore gale is blowing. The bore is said to enter the river at the rate of 14¼ miles an hour, and during the first hour the rise of tide is ten feet. Its approach can be heard for a distance of fourteen or fifteen miles. The Severn bore is too well known to need description. Its height has been estimated at three to four feet, and velocity at seven to eight miles an hour.

In another section the author deals with wave motion: first with wind waves and secondly with seismic and cyclonic storm waves. As a civil engineer, his chief interest is with the effects of wave motion upon harbour works, coast defences, and other constructions; but these chapters also give an excellent summary of the theory of deep-sea waves and the results of observations on their dimensions and speeds. Some of the facts recorded as to damage done by wave action are very striking. During the construction of Plymouth breakwater, blocks of stone weighing from seven to nine tons were carried over the top through a distance of 138 feet and deposited inside the breakwater. At Bilbao a solid block of the breakwater weighing 1700 tons was overturned. The partial destruction of the north pier at Tynemouth furnishes another illustration; in that case there can be no doubt that the depth below still-water level to which wave disturbance was likely to go in that locality had been considerably underestimated. As to earthquake and cyclonic waves, Mr. Wheeler has collected a large amount of information of an interesting character, and he deals at some length with "solitary" ocean waves, which he thinks are chiefly due to submarine disturbances. The great majority of the solitary waves that have been observed in the North Atlantic were in a line between places subject to volcanic activity. One of the latest examples of the destructive effect of a solitary wave occurred in October, 1905, to the Cunard liner *Campania* on her outward voyage to New York. A fresh gale was blowing on the Grand Banks of Newfoundland when the ship was suddenly struck by an enormous wave; she lurched over, the water swept over the deck several feet deep, five passengers were washed overboard and twenty-nine others seriously injured. This wave was said to have reached as high as the funnels, but in the circumstances accurate estimates could hardly have been made.

The final chapter deals with tides as a source of power. The author gives full accounts of applications of the principle that have been made at various times, but his conclusion is that the attempt to utilise tides on a large scale with existing mechanical appliances cannot be considered as coming within the lines of commercial economics. In this conclusion he has the support of general engineering opinion.

On the whole, Mr. Wheeler has succeeded in the object he had in view, and has "produced a handbook that will be of interest and practical service to those who have neither the time nor the opportunity of investigating the subject for themselves." W. H. W.

ELECTRICITY METERS.

Electricity Meters. A Treatise on the General Principles, Construction, and Testing of Continuous Current and Alternating Current Meters for the Use of Electrical Engineers and Students. By Henry G. Solomon. Pp. x+323. (London: Charles Griffin and Co., Ltd., 1906.) Price 16*s*. net.

UNTIL a few months ago the literature on the subject of electricity meters was entirely confined to articles in text-books on electrical engineering, and the advent of a book dealing exclusively with this subject is therefore a matter of importance to those interested in the distribution of electrical energy. In the book just published by Messrs. Griffin, Mr. H. G. Solomon has written a clear and comprehensive treatise on the principles and construction of this most important piece of electrical apparatus.

The first chapters are introductory, and deal mainly with the theory of action of the more important types. In chapter ii. an important section on the behaviour of three-wire energy meters is deserving of attention. The errors in reading due to want of balance, both as regards pressure and current on a three-wire system, when the shunt coils of a three-wire meter are connected respectively across the outers, and between the middle wire and the outer, have been worked out. In the appendix figures are given which show the percentage error in different cases, and the advantage of connecting the shunt coil directly across the outers is clearly proved. The fact that there is any error at all with this arrangement has hardly been recognised, though for switchboard meters the matter is certainly one of importance. The following chapters contain descriptions of the various types of quantity and energy meters for continuous current circuits, and are largely reminiscent, as writing of this kind must always be, of manufacturers' pamphlets.

Mr. Solomon has very wisely excluded all historical and out-of-date meters from this part of his book, and the section contains a clear description, fully illustrated by many excellent drawings, of the meters which the central station engineer has to use and to test. The author is to be congratulated on having almost entirely eliminated illustrations of the outer cases of the instruments which he describes, a type of illustration, unfortunately, all too common in some other works on kindred subjects. Chapter vi. contains a description of continuous meters for special purposes. The last section deals with tramcar meters. The practical importance of this type of meter is hardly yet well recognised. As Mr. Solomon says:—"The careless manipulation of the controller and brake is a matter of serious importance, resulting in a considerable loss of energy. By properly recording the actual energy taken by the cars, and keeping records of the motor men, a saving amounting to from 10 to 20 per cent. of the total used can be effected." The descriptions of the best known types of meter for this purpose are somewhat disappointing.

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